ENHANCED BACKSCATTERING FROM ROUGH SURFACES

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Contractor: Imperial College
Contract Number: DAJA45-87-C-0039

2nd Periodic Report

September-December 1987
(Report Date: 18th January 1988)

"The research reported in this document has been made possible through the support and sponsorship of the US Government through its European Research Office of the US Army. The report is intended only for the internal management use of the Contractor and the US Government."

1 Progress During Reporting Period

Andrew Sant (graduate student employed on Contract from 10/87) has started a bibliography on surface and volume enhanced backscattering: the current version is appended. Minor upgrades to the scatterometer have been made (e.g. purchase of half-wave plate for 10.6 μm and a quarter-wave plate for 633 nm) and the options for extending the wavelength coverage to the 1-4 μm range are being evaluated in detail. Some two-dimensional surfaces (random gratings) have been made and are currently being measured.

Some preliminary measurements of the Stokes' parameters as a function of scattering angle have been made for surface #83 at normal incidence and λ = 633 nm (used by O'Donnell and Mendez[1], Fig 9). Figure 1 shows these results, for s-polarisation incident. The physical interpretation of the four Stokes' parameters is:

S_0 : total intensity, I_{tot}
S_1 : 'intensity of horizontal/vertical linear component'
S_2 : 'intensity of 45°/135° linear component'
S_3 : 'intensity of RH/LH circularly polarised component'

The intensity of the polarised component is $I_{pol} = \sqrt{S_1^2 + S_2^2 + S_3^2}$ and therefore that of the unpolarised component is $I_{unpol} = I_{tot} - I_{pol}$. In Fig 1, S_2 and S_3 are small: we have not yet evaluated whether these values are "real" or whether they are a residual error of the measurement technique. If S_2 and S_3 are indeed negligible, then this means that the scattered light consists of a linearly polarised component (S_1) along the same direction as the incident linear polarisation, plus an unpolarised component equal to (S_0 - S_1) in this case. Figure 2 plots these two quantities using data measured earlier in the co- and cross-polarised directions (I_{ss} and I_{sp}): assuming that S_2 and S_3 are ≈0, it follows that $I_{pol} \approx I_{ss} - I_{sp}$ and $I_{unpol} \approx 2I_{sp}$. *Note that the enhanced backscatter peak is almost entirely unpolarised.*

During calibration of the scatterometer we measured a freshly prepared Magnesium Oxide surface, which is frequently claimed to be a good approximation to a Lambertian scatterer[2]. As the results in Fig 3 show, *it exhibits the enhanced backscatter peak*! The energy in this peak is small and the scattering is quite Lambertian for incident angles <30°.

2 Research Plans

During the next six months we hope to characterise and measure a number of two-dimensional surfaces (random gratings) for comparison with the numerical calculations of Nieto-Vesperinas and Soto-Crespo[3]. A more detailed study of the Stokes' parameters from three-dimensional surfaces will be carried out. We shall also extend the wavelength range of the scatterometer.

3 Administrative Actions

Dr A T Friberg has been appointed a Research Assistant for the period 1/1/88 to 31/3/88.

4 Other

J C Dainty is Chairman of the Topical Area on "Imaging, Propagation and Scattering through Random Media", at the ECOOSA Conference, Birmingham, UK, 22-25th March, 1988 and this Area includes a Session on "Enhanced Backscattering".

References

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2 See, e.g., R S Longhurst, *Geometrical and Physical Optics*, 3rd Edition,Longman, 1973 §18-2.
3 M Nieto-Vesperinas and J Soto-Crespo, Opt Lett, **12**, 979 (1987)

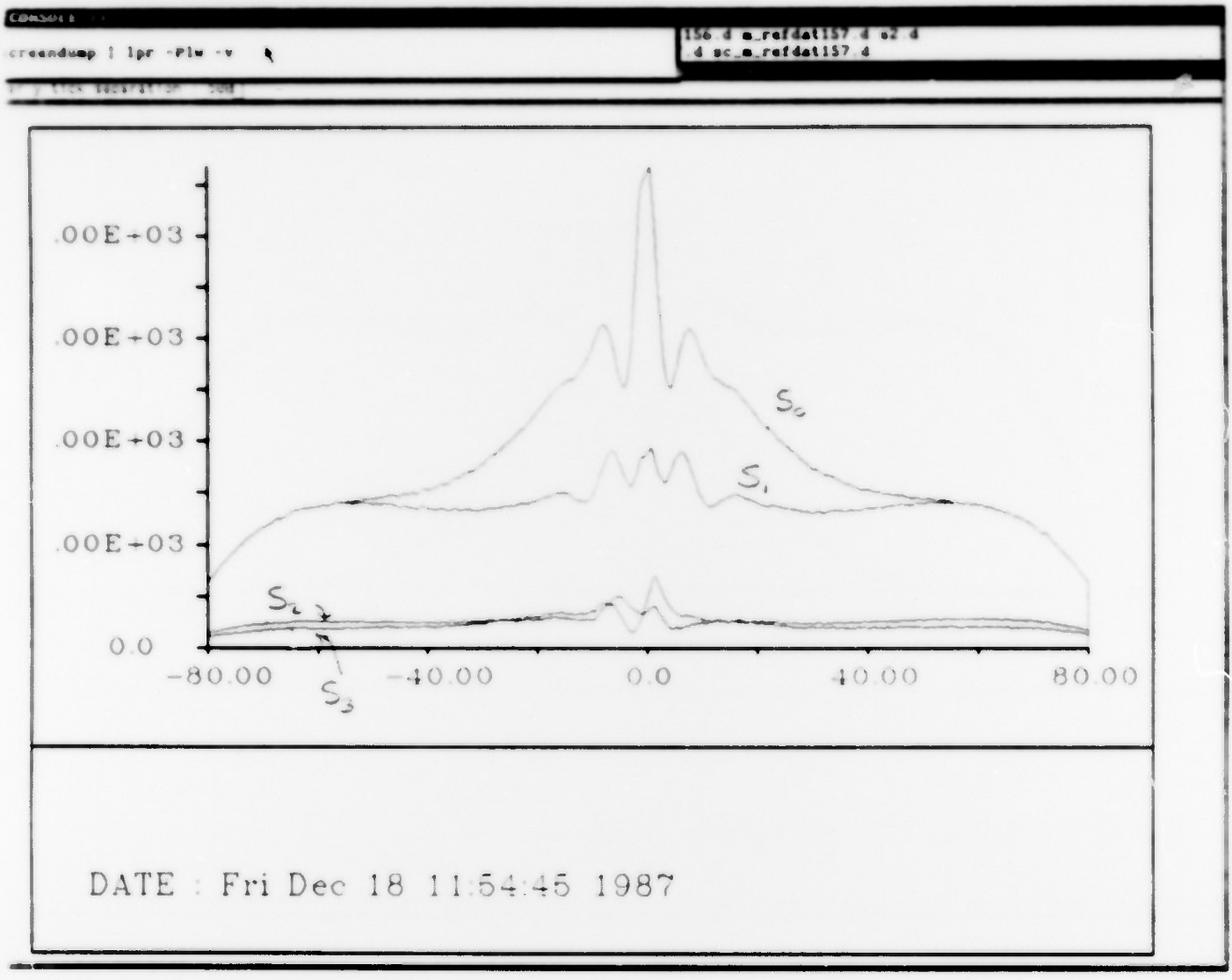
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Figure 1

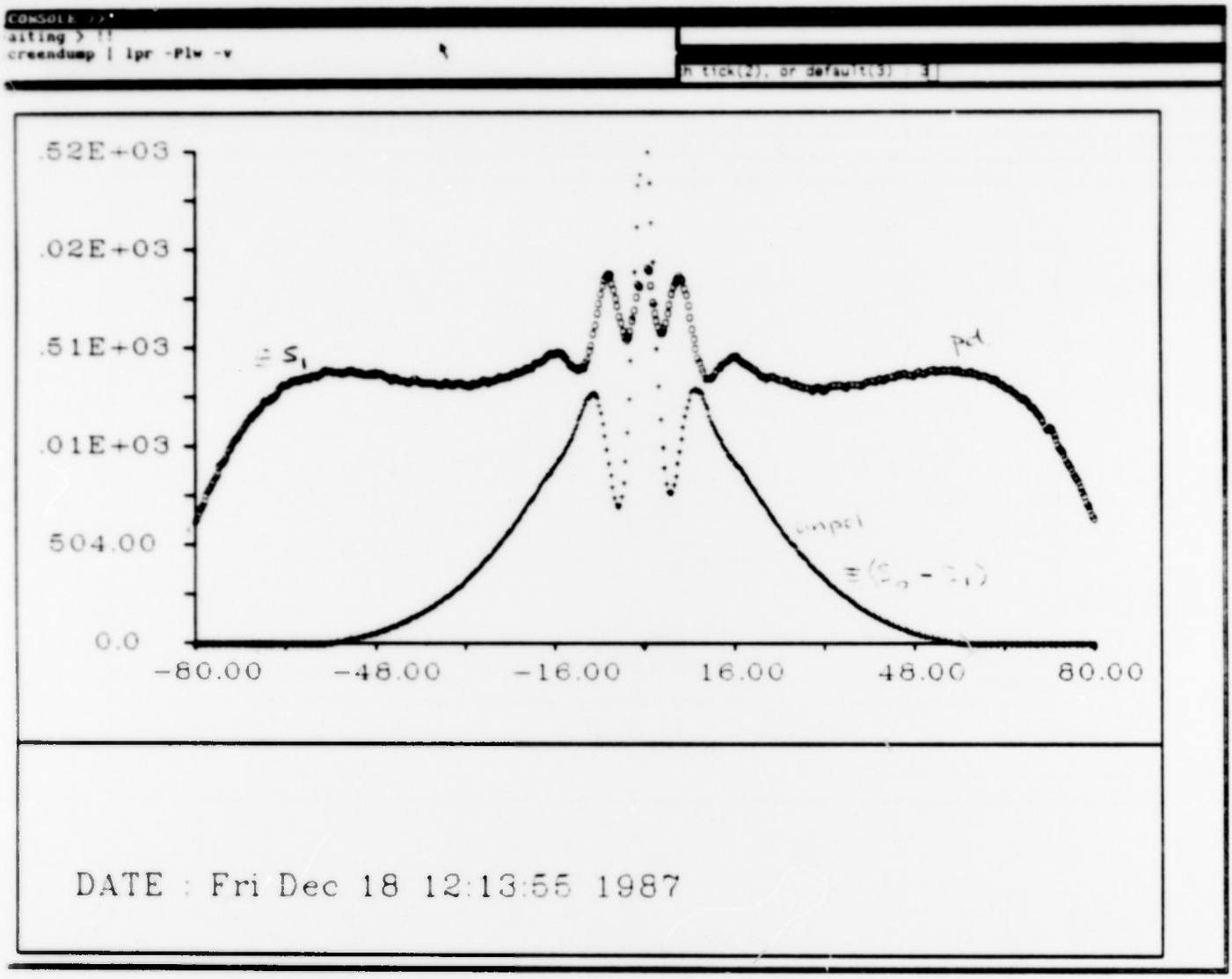
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Figure 2

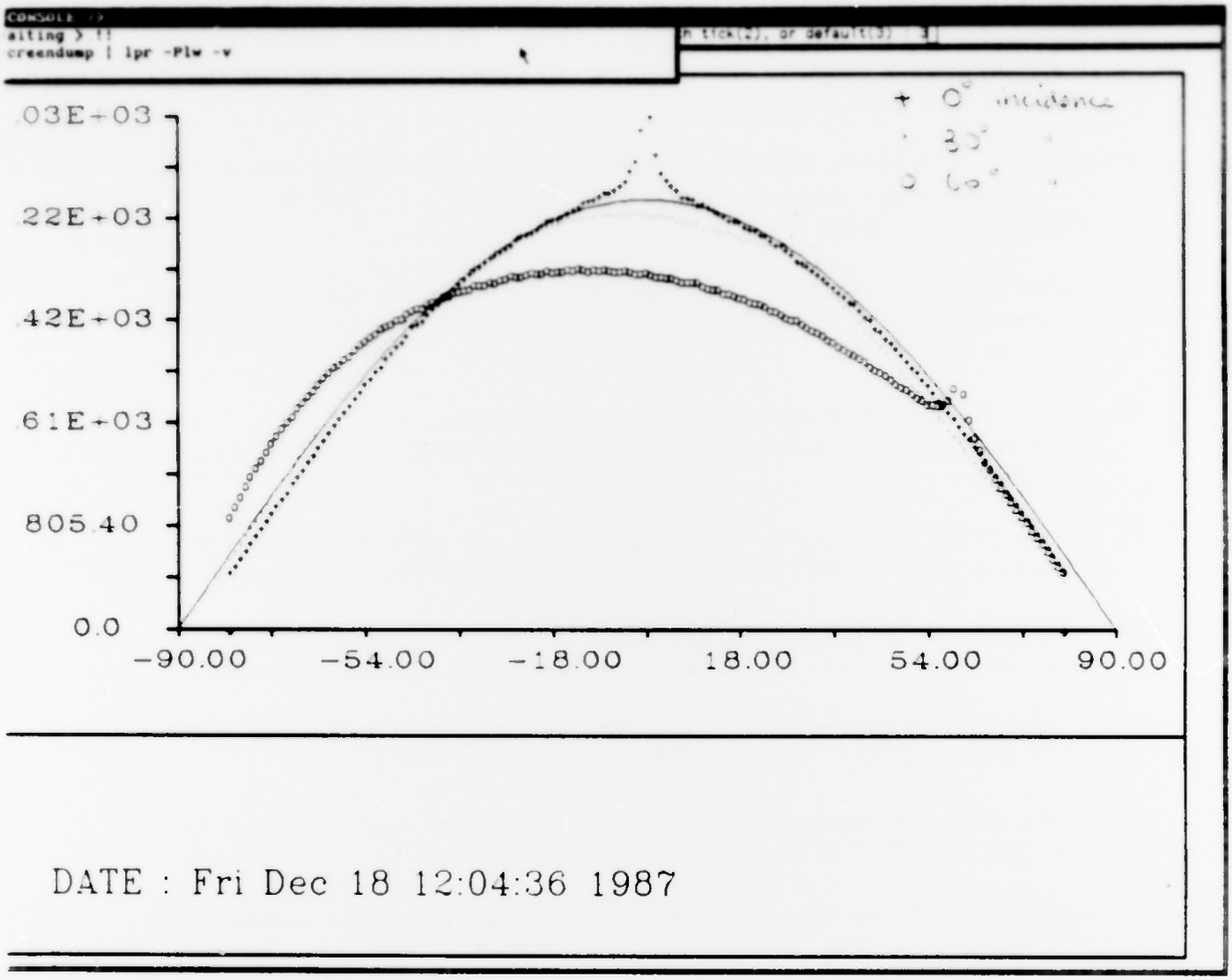
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Figure 3

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